

Discovery and New Frontiers News

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Solar Sailing Maneuvers MESSENGER for Second Mercury Flyby

Preparations for [MESSENGER](#)'s upcoming second flyby of Mercury continue to proceed on schedule. At 4:40 a.m. ET on October 6, the spacecraft will speed by the planet, passing within 125 miles and gaining a gravity assist that will tighten its orbit and keep it on course to pass the planet one last time next year before becoming the first spacecraft ever to orbit Mercury, beginning in March 2011.

A comprehensive set of observations of Mercury and its environment is designed for the upcoming encounter – deploying all seven of the science payload instruments, in addition to the telecommunications system – to continue the investigations begun during the first encounter.

As MESSENGER flew by Mercury on January 14, its instruments imaged 20% of the surface not previously seen by spacecraft. The probe made measurements of the planet's magnetic field, exosphere and sodium tail, surface color and composition, and gravitational field. On its second visit, MESSENGER will get close to the opposite side of the planet and image an additional 30% of the surface never before seen by spacecraft.



This is the last image the Mercury Dual Imaging System (MDIS) took during MESSENGER's first flyby of the planet last January. Even at this great distance, the giant Caloris basin can be identified as a brighter circular region in the upper right of the planet.

Credit: NASA/Johns Hopkins University Applied Physics Laboratory/ Carnegie Institution of Washington

On September 4, the team announced that it would not need to implement a scheduled maneuver to adjust the probe's trajectory. This is the fourth time this year that such a maneuver has been called off due to a recently implemented navigational technique that makes use of solar-radiation pressure (SRP) to guide the probe. It has been extremely successful at maintaining MESSENGER on an accurate trajectory.

SRP is small and decreases by the square of the distance away from the Sun. Unlike rockets, the "solar sailing" technique requires no fuel. While SRP's thrust is small, it will continue as long as the Sun is shining and the "sail" is deployed, providing a continuous acceleration source for the probe.

The Mercury flybys are designed to take the probe within approximately 125 miles of the planet, so precision targeting is critical. Fly too low and the probe could crash into the planet. Fly too far away and MESSENGER might have to use its reserve fuel to correct for the acceleration loss. Either way, getting off target could jeopardize the mission.

SRP was seen as an impediment to precise targeting, until the first Mercury flyby in January 2008. About 26 days before that historic event, MESSENGER fired its thrusters to fine-tune its trajectory but the probe was still about 6 miles off from its target. They had one more opportunity for another trajectory correction maneuver four days before the flyby, but were able to skip it by solar sailing the spacecraft closer to the intended aim point.

The team tilted MESSENGER's solar panels an extra 20 degrees away from the Sun, and the resulting change in solar-array orientation moved the flyby altitude very close to the target aim point. Ultimately, MESSENGER missed its target altitude by less than one mile.

Inside

MESSENGER Set for 2nd Mercury Flyby	1
New Horizons Wakes Up	2
Dawn Plans Gravity Assist	2
EPOXI Observations End	3
Stardust NeXT Continues Cruising	3
M³ Prepares for Launch	4
Kepler Testing In Progress	5
Juno Confirmed	5
GRAIL Proceeding to PDR	6
Discovery@Folklife Festival	6

<http://discoverynewfrontiers.nasa.gov/>

The MESSENGER team has planned a more extensive use of this technique for the second Mercury flyby. They have developed a process to use the SRP force as a control for the trajectory that should reduce the number of trajectory correction maneuvers needed in the future.

According to NASA, in 1974, when the Mariner 10 spacecraft ran low on attitude-control gas, its engineers angled the spacecraft's solar arrays into the Sun and used solar radiation pressure for attitude control, and it worked. But MESSENGER's use of the technique represents the first time that a spacecraft has successfully used solar sailing as a propulsion-free trajectory control method for the targeting of planetary flybys.

Education and Public Outreach Highlights

The MESSENGER project is on [Twitter](#), the free micro-blogging service, offering frequent brief updates about the mission.

The July 4 issue of the journal *Science* included a special 35-page section on the results of MESSENGER's first flyby of Mercury.

On August 12, MESSENGER Project Scientist Ralph McNutt from the Applied Physics Lab (APL) delivered a lecture in two venues on "Mercury in a New Light: The First MESSENGER Flyby." He spoke to employees at NASA's Langley Research Center in Hampton, Virginia, in the afternoon and gave a public lecture at the Virginia Air and Space Center in Hampton in the evening.

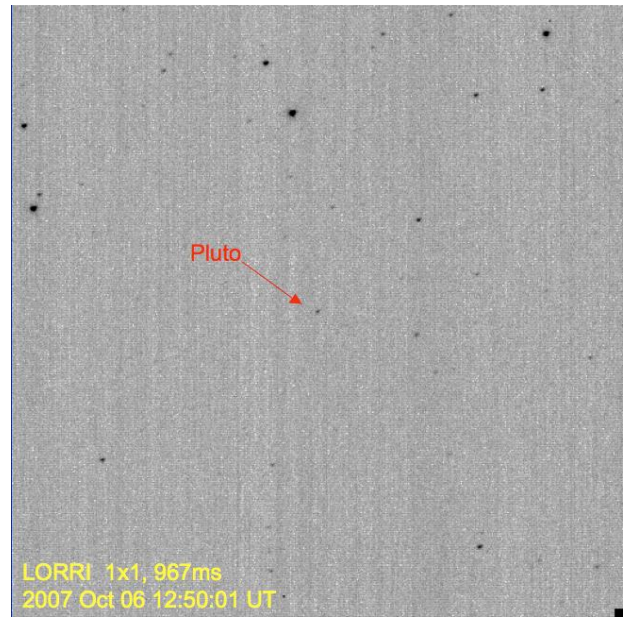
On August 27, Mercury Dual Imaging System instrument scientist Louise Prockter from APL spoke on "New Imaging of Mercury" to the North Norfolk Astronomy Club in Fakenham, Norfolk, England.

New Horizons Wakes Up for Checkout #2

On September 2nd, the [New Horizons](#) spacecraft was successfully transitioned from Passive Spin Hibernation mode to Passive Spin Normal mode to prepare for its annual checkup. The spacecraft had been in hibernation since February of this year. The Annual Checkout # 2 activities began on September 3rd as the spacecraft was put into Active Spin Normal mode.

Since launch in January 2006 and the flyby of Jupiter for a gravity assist in February 2007, the spacecraft is in "interplanetary cruise mode" until it reaches the vicinity of Pluto in April 2015. It will spend much of that cruise time hibernating with regular status checks made via NASA's [Deep Space Network](#) (DSN).

The spacecraft had an uneventful August, after a scare on July 7 when the weekly beacon check-in via the DSN revealed that New Horizons was transmitting a "red," or emergency, beacon instead of its familiar "green," nominal flight, beacon. This meant the spacecraft had experienced a significant anomaly. The mission operations team and the DSN tracking stations immediately swung into action, contacting the spacecraft that evening and downloading telemetry diagnostics the next day. By mid-week the operations team had diagnosed the problem and devised a recovery strategy.



This image shows the first detection of Pluto using the high-resolution mode on the Long-Range Reconnaissance Imager (LORRI). Taken on October 6, 2007, the hi-res mode provides a clear separation between Pluto and numerous nearby background stars. New Horizons was still too far from Pluto, 2.2 billion miles, for LORRI to resolve any details on Pluto's surface – that won't happen until summer 2014, approximately one year before closest approach.

Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

The main flight computer had unexpectedly reset itself after becoming hung up in a software loop. By July 11, the operations and engineering teams had assessed this anomaly, determined that it was safe for the spacecraft to re-enter hibernation, and commanded New Horizons to do so. The team is still working to reproduce the failure on the ground to learn exactly what took place.

At the beginning of September, the spacecraft was 10.63 AU from the Earth, 10.90 AU from the Sun, and 20.68 AU from Pluto (astronomical units – the distance from the Earth to the Sun). New Horizons is the first spacecraft to venture this far since the second of the Voyager spacecraft accomplished the same milestone in the summer of 1981. It is now nearly 60 million miles beyond Saturn, and will cross the orbit of Uranus – about 1.2 billion miles from the Sun – in March 2011.

Education and Public Outreach Highlights

The New Horizons project is on [Twitter](#), the free micro-blogging service, offering frequent brief updates about the mission.

Dawn Plans for Upcoming Gravity Assist

The [Dawn](#) mission to asteroids Vesta and Ceres continues on its long journey with the spacecraft in good health and operating normally. Since launch on September 27, 2007, Dawn has traveled 231 million miles from Earth and is currently traveling at a speed of nearly 105,000 miles per hour relative to Earth.

In July, the Dawn team initiated an operational readiness test to demonstrate the flight team's ability to implement a trajectory correction maneuver utilizing the ion engine, in preparation for the February 2009 Mars Gravity Assist. Also in July, the flight operations team performed a solar array calibration test to characterize the power and ion propulsion system performance given various spacecraft off-sun angles. This activity allows better characterization of the arrays' power production when the spacecraft is at larger solar distances which correlates directly to the efficiency of ion thrusting. The thrusting efficiency profile will ultimately affect the time available for science at Vesta and robustness of the plan to reach Ceres on schedule.

In August, the project was working to finalize instrument and flight system activity plans and reviewing plans for the Mars Gravity Assist.

Education and Public Outreach Highlights

On August 8, the Dawn mission hosted a "Webinar" featuring science team member Dr. Lucy McFadden describing her experience as part of a team of eight scientists who spent 42 days in Antarctica last year. McFadden, a research professor from the University of Maryland who leads the Dawn Education and Public Outreach team, was invited to join the annual expedition to the Miller Range of Antarctica as part of the National Science Foundation's (NSF) Antarctic Meteorite Search Program 2007-2008.

In this interactive webinar, McFadden recounted the excitement of her scientific expedition and how it has propelled her enthusiasm to explore the small bodies in the solar system through NASA Discovery missions that she participates in: NEAR, Deep Impact, Dawn, and EPOXI.

Since 1976, the NSF has supported an annual search for meteorites during the Antarctic summer, late November - January. The team of eight scientists spent 42 days searching for meteorites on foot and by snowmobile and lived in tents set up on the ice.



Meteorites found during the 2007 search. Left: A meteorite measuring 1 x 0.5 x 1 cm with 95% fusion crust. Right: A meteorite measuring more than 6 cm long with sparse fusion crust covering only 1% of the specimen.

Credit: ANSMET 2007 Case Western Reserve University

More than 100 participants joined the Webinar. Listen to the archived presentation and view the slides at:
<http://video.google.com/videoplay?docid=6581948984331024457&hl=en>

EPOXI Observations Conclude

EPOXI, the follow-on mission that is re-purposing the Deep Impact spacecraft to look for planets around other stars and to fly by comet Hartley, ended the EPOCh (**E**xtrasolar **P**lanet **O**bservation and **C**haracterization) portion of the mission on August 31.

In June, the EPOXI Flight Team implemented a flawless trajectory correction maneuver, TCM-12, targeting the spacecraft onto an alternate trajectory which will provide more favorable science gathering opportunities during Hartley 2 observations that are scheduled for November 4, 2010.

Education and Public Outreach Highlights

In July the EPOXI mission released the [Earth-Moon movie](#) captured by the Deep Impact spacecraft from observations of a full day of the Earth rotating in space on May 28-29, 2008. The images were acquired when the spacecraft was just outside the orbit of the Earth and ahead of Earth by 31 million miles, or one-third AU, making it as far from Earth as Mercury is from the Sun.



What does the Earth look like from a distance, as seen by the Deep Impact spacecraft? As part of the EPOXI missions objectives to characterize the Earth for comparison with planets around other stars, the spacecraft collected a series of images as the Moon was beginning its transit in front of the Earth.

"Making a video of Earth from so far away helps the search for other life-bearing planets in the Universe by giving insights into how a distant, Earth-like alien world would appear to us," said University of Maryland astronomer Michael A'Hearn, EPOXI principal investigator.

Stardust-NeXT Continues Cruising

The venerable [Stardust](#) spacecraft, continuing on as Stardust-NeXT, or New Exploration of Tempel 1, continues on its journey to revisit the comet encountered by the Deep Impact spacecraft in 2005. In July Trajectory Correction Maneuver 22 (TCM-22) was successfully accomplished, refining the trajectory to target the comet. The Deep Space Network will contact the spacecraft monthly until November when TCM-23 is planned.

The first science team meeting will be held the Sunday before the Division for Planetary Sciences annual conference in October in Ithaca, NY.

Decontamination and calibration of the NAVCAM is scheduled for December, with an Earth Gravity Assist scheduled for January 14, 2009. The flyby of Tempel 1 will take place in 2011.

Education and Public Outreach Highlights

The Stardust sample return capsule went on public display at the Smithsonian National Air and Space Museum's Milestones of Flight Gallery in Washington D.C. on Oct. 1, the 50th anniversary of NASA.

The capsule, which carried the collected particles of comet dust back to Earth on Jan. 15, 2006, joins the Wright brothers' 1903 Flyer, Charles Lindbergh's Spirit of St. Louis and the Apollo 11 command module Columbia that carried the first men to walk on the moon.

"The Smithsonian Institution's National Air and Space Museum is delighted to add to the National Collection the Stardust return capsule," said Roger Launius, senior curator of the Division of Space History at the museum. "As one of the premier space science missions of the recent past, Stardust will take its place alongside other iconic objects from the history of air and spaceflight. I look forward to helping to impart more knowledge to our visitors about the makeup of the universe using this significant and pathbreaking object."



The Stardust Sample Return Capsule at its new permanent home in the Milestones of Flight Gallery near the Apollo capsule.

M³ Prepares for Launch

The [Moon Mineralogy Mapper](#), or M³, instrument, is set to fly aboard the Indian Space Research Organization's (ISRO) Chandrayaan-1 spacecraft, with current plans aiming for an October 22 launch date.

Extensive tests on both the instruments and the spacecraft have been conducted throughout the summer. M³ underwent an electrical integration test, an integrated systems test, and instrument to spacecraft functional tests. Tests on the Chandrayaan-1 spacecraft include vibration, acoustic, thermal vacuum, radio frequency, functional, and integration tests. By the end of August, all spacecraft subsystems had been integrated and tested. All the panels were mounted and major internal reviews were initiated to lead to launch readiness.

Partnering with the space agency of a foreign country results in many challenges that need to be resolved, including communication and radio frequency compatibility issues to assure the transfer of data files, notably the crucial science results. Issues being worked include X-band compatibility to assure optimal communications between the spacecraft instruments and the Deep Space Network, transferring data files from ISRO to NASA's Jet Propulsion Lab (JPL) which built M³ and the Applied Physics Lab (APL) which built the Miniature Synthetic Aperture Radar (MiniSAR) instrument.

Education and Public Outreach Highlights

The M³ E/PO team conducted a training session for the educators who are part of [The Aerospace Education Services Project](#) (AESP). AESP is a comprehensive project designed to reach out to the formal and informal education communities in all fifty states and the U.S. territories. The AESP staff consists of specialists who are professional educators assigned to each NASA center to connect NASA to K-12 education. The mission training used the M³ E/PO activities and ALTA spectrometers to teach the educators about identifying characteristics, demonstrating that fingerprints are similar to rock spectra.



Educators taking spectra of different rocks.

The mission is launching an on-line "Geology of the Moon" course through Montana State's National Teachers Enhancement Network from September 15 – November 15 for middle-early high school teachers. Twenty-eight

elementary to high school teachers have enrolled, logging in from all over the globe, including Guam, Puerto Rico, Alaska, and Maine.

Kepler Testing Continues

Comprehensive performance testing of the [Kepler](#) mission flight segment and ground segment took place throughout the summer. The Flight Segment Thermal Vacuum Test came to a successful conclusion in mid-September. Cold survival testing was completed, and the chamber was returned to ambient conditions. Much useful information was collected to assist with characterization and analysis of this and other test results.

The Kepler launch date is now scheduled for no earlier than April 10, 2009 due an issue on Delta II launch vehicle.



Kepler's target region in the Milky Way galaxy. Credit: Jon Lomberg

The [Kepler Guest Observer Program](#) released the Cycle 1 Announcement of Opportunity on July 17, with Notices of Intent due on Sept. 5 and proposals due on Oct. 24. This program solicits proposals for the acquisition and analysis of new scientific data from the Kepler mission. Observations will begin immediately following the successful scientific commissioning of the spacecraft. During its 3.5-year prime mission, Kepler will continuously monitor a ~100 square degree field-of-view (FOV) in the Cygnus region, with the objective of photometrically detecting transits of Earth-size planets in the habitable zone. The instrument's high-precision photometry capability, with two available cadence modes (1 minute and 30-minute) is also sufficient for asteroseismology research and other variability analyses of both Galactic and extragalactic sources. Proposals submitted to this program should be for new observations only and should address areas of astrophysics outside of the exoplanet transit survey Key Project already planned by the mission.

The full announcement of opportunity is part of the NASA Research Announcement "Research Opportunities in Space and Earth Sciences (ROSES) 2008" (NNH08ZDA001N) and can be found on the NASA research opportunity homepage at <http://nspires.nasaprs.com/> (select "Solicitations" then "Open Solicitations" then "NNH08ZDA001N"). Questions about this program can be directed to the Kepler Guest Observer Office at keplergo@arc.nasa.gov.

Education and Public Outreach Highlights

A new series of [StarDate](#) radio programs that feature the Kepler mission began airing in July. Broadcast in English and Spanish on more than 500 radio stations daily, StarDate is the public education and outreach arm of the University of Texas [McDonald Observatory](#). Listen to the Kepler segments at [Kepler web site](#).

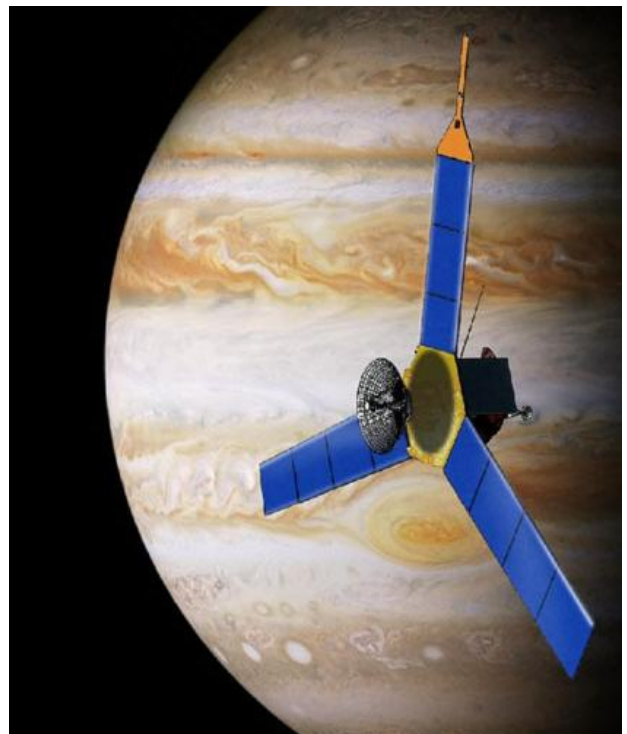
Pilot showings of the *Strange Planets* planetarium show about Kepler were presented at the Lawrence Hall of Science at the University of California-Berkeley from July through September. Analysis of formative evaluation feedback from show attendees was reviewed by the team. Show kits are being designed for fall field tests at other 8 other planetariums.

The mission plans to offer 4 to 6 pre-launch educator workshops in a variety of locations. Arrangements are being made with local hosts to support the workshops. Kepler will provide teachers who attend with mission materials including orreries for transit demonstrations.

There's still time to [send your name](#) to space with Kepler.

Juno Mission Confirmed

The [Juno](#) project accomplished a key mission milestone in August. At a Confirmation Review on August 5 at NASA Headquarters, the mission was approved to proceed into the design phase of the mission. The new effort officially began on September 1.



Artist's rendering of Juno at Jupiter.

In July the project held management and technical interchange meetings at Selex Galileo in Florence, Italy, for the Jovian Infrared Auroral Mapper (JIRAM) instrument and at Thales Alenia Space in Rome for the Ka-Band Translator.

In August the Juno system engineering team held a Probabilistic Risk Assessment tabletop meeting as part of their activity for compliance with NASA Planetary Protection requirements. Later in the month the Juno Radiation Team held a Radiation Advisory Board meeting at JPL.

The NASA Flight Planning Board issued the Authority to Proceed for the Juno Launch Services contract with a launch window of August 7 to 27, 2011.

In September, the Juno science team met at Caltech and participated in a Science Operations Workshop.

Juno project manager, Rick Grammier, has transitioned into a new position at JPL as Deputy Manager of the Solar System Exploration Division. Welcome to Jan Chodas, who has taken over as the new Juno project manager.

Education and Public Outreach Highlights

A presentation on the Juno mission was given to students in the University of Wisconsin-Madison's PEOPLE Program, which is an advanced studies program for minority middle school students.

Juno mission content and concepts are part of a planetary science curriculum produced by the Lawrence Hall of Science in Berkeley, CA, that is currently being field tested after piloting at several Berkeley-area schools.

Updated curriculum materials produced by Lewis Center for Educational Research will be piloted this fall.

GRAIL Proceeding toward PDR

The Gravity Recovery and Interior Laboratory, or [GRAIL](#), the most recently selected Discovery mission, will fly twin spacecraft in tandem orbits around the Moon for several months to measure the lunar gravity field in unprecedented detail continue to be addressed.

The project has made several changes to the proposed mission baseline resulting from trade studies, analyses, and inheritance assessment. A series of segment Preliminary Design Reviews (PDRs) will take place through November 5, leading up to the full project PDR scheduled for Nov. 11-14.

The GRAIL science team had its quarterly science team meeting on July 29 and 30, at the National Academy of Sciences in Woods Hole, MA.

It was focused on GRAIL science objectives and synergistic opportunities with Lunar Reconnaissance Orbiter's Lunar Orbiter Laser Altimeter instrument.

Discovery Missions Featured at the Folklife Festival

Discovery's asteroid and comet missions were featured at the NASA Space Science area during the Smithsonian Folklife Festival on the National Mall in Washington D.C., where NASA was honored for 50 years of exploration. Held the last week of June and the first week of July, NASA showcased the role that the agency's men and women have played in American technology, science and culture.

The NASA program included demonstrations of skills and techniques, hands-on educational activities, and exhibits that conveyed NASA's spirit of inspiration, innovation and discovery. More than 1 million visitors attended the festival.

Kids of all ages loved the comet cratering activity where they could throw marbles and rocks of varying sizes into layers of flour, to simulate asteroids and meteoroids hitting the Moon. It was one of six official activities in the "NASA 50 Years and Beyond" mission guide handed out to all children. After completing each activity, the kids received a NASA space shuttle decal. Those who got all six received another prize.

Adults were very interested in the asteroid and comet models and the stories behind our missions. Stardust had a large display with samples of aerogel and posters illustrating the comet dust extraction process and initial science results.



Students try their hand at making craters.

The comet area was organized by Aimee Meyer from Stardust-NExT and staffed by Shari Asplund, John Ristvey from Dawn, Elizabeth Warner from EPOXI, and members of the sample curation team from Johnson Space Center. Members of the MESSENGER team also staffed a table featuring the mission to Mercury.

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